GENERIC VERIFICATION PROTOCOL

FOR

THE ADVANCED MONITORING SYSTEMS PILOT

October, 1998

Prepared By:

BATTELLE
505 King Avenue
Columbus, OH 43201

Reviewed and Recommended By:

The Environmental Technology Verification's
Advanced Monitoring Systems pilot
Air and Water Stakeholder Committees

Supported By:

A Cooperative Agreement (CR826215)
with the U.S. Environmental Protection Agency

GENERIC VERIFICATION PROTOCOL

FOR

THE ADVANCED MONITORING SYSTEMS PILOT

VERSION 1.0

APPROVAL

Robert Y Fuerst
EPA Pilot Manager, Robert Fuerst

12-14-98
Date

Karen Riggs
Battelle Pilot Manager, Karen Riggs

12/18/98
Date

TABLE OF CONTENTS

Page

1. INTRODUCTION

The Environmental Technology Verification program (ETV) is a novel effort being conducted by the U.S. Environmental Protection Agency (EPA) to promote the acceptance in the marketplace of commercial-ready environmental technologies. The purpose of ETV is to provide credible third party performance data on environmental technologies, so that users, developers, regulators, and consultants can make informed judgments about such technologies. ETV is not an approval or certification process, but rather provides a quantitative assessment of technology performance. EPA quality management staff participate in the performance verification process, assuring high quality and credibility of the data produced. The ETV program consists of twelve pilots each addressing a different technology area, and conducted by diverse "verification organizations" who serve as EPA's partners in the program.

Battelle is EPA's partner in the Advanced Monitoring Systems (AMS) pilot within the ETV program. The purpose of the AMS pilot is to verify the performance of commercial technologies for monitoring air, water, and soil, with an initial emphasis on air and water technologies. Battelle is the world's largest contract research and development organization, with nearly 10,000 staff in laboratories and offices around the world. The AMS pilot is led by staff from Battelle's Columbus, Ohio headquarters.

The AMS pilot's scope encompasses the full range of environmental monitoring technologies. Air monitoring technologies could address ambient air, stationary source emissions, or indoor air, while water monitoring technologies could address drinking water, surface water, groundwater, waste water, and sediment. Remote monitoring systems, field instruments, continuous emission monitors, and laboratory analytical instruments could all be considered for verification. Similarly, technologies could monitor for organic compounds, inorganic compounds, or biological contaminants. The focus is on technologies that are needed and available but not yet widely used.

Stakeholders assist Battelle in conducting the AMS pilot. Two stakeholder committees have been formed to date - one focused on air monitoring and the other on water monitoring. Stakeholders represent regulated industries and agencies, EPA and state regulating agencies,

technology users, professional and trade associations, public interest and environmental groups, and the financial community (insurance underwriters and venture capitalists). These stakeholders advise Battelle on technology needs, verification protocols, and other issues. A list of the AMS stakeholders can be found on EPA's ETV web site - www.epa.gov/etv, along with more detailed information about the ETV program and the AMS pilot. On the basis of stakeholder recommendations, Battelle solicits interested technology vendors and works with them to develop test/quality assurance (test/QA) plans and to conduct and report on verification testing.

In the AMS pilot, the performance of commercial-ready technologies is quantified by comparison in realistic conditions to EPA standard methods, certified standards, or other recognized methods. This pilot does not supersede existing EPA monitoring evaluation programs. For example, monitors for the criteria pollutants in ambient air (nitrogen oxides, ozone, sulfur dioxide, etc.) are already subject to the Reference and Equivalent Method designation process (40 CFR Part 53). However, with EPA's move toward a Performance Based Measurement System (PBMS),[(1)] the focus now is on methods that are demonstrated to give the needed data quality, rather than on prescribed measurement procedures. One goal of the AMS pilot is to further the acceptance of novel technologies through PBMS-accepted testing procedures.

The AMS pilot benefits vendors of monitoring technologies in several ways. Benefits to vendors include:

- Increased credibility from having independent performance data;
- Access to expertise in verifying and applying monitoring technologies;
- Increased likelihood of regulatory acceptance, and reduction in multiple state and local demonstrations, due to wide recognition of ETV results;
- Increased recognition in international markets through EPA outreach;
- Increased confidence for investors.

Users and permitters of environmental technologies benefit from the AMS pilot through:

- Technology performance verification independent of vendor claims;
- Performance-based verification testing addressing realistic data quality objectives (DQOs);
- EPA support of the verification test results.

This document is the Generic Verification Protocol for the AMS pilot. This document sets forth the general path that will be followed in soliciting, testing, and reporting on monitoring technologies. This protocol is intended to be a guide on how to conduct the entire verification process. As such, it does not deal with the details of specific verification tests or technologies. Rather, it presents a framework within which each verification test is to take place. The purposes of this Generic Verification Protocol are:

- To promote uniformity in the verification testing conducted in the AMS pilot;
- To provide a framework for development of detailed test/QA plans for verification of monitoring technologies; and
- To allow simplification of test/QA plans by addressing the general procedures of the AMS pilot.

Subsequent sections of this document address the steps leading up to a verification test; the general features and organizational responsibilities of a verification test; the required content of a test/QA plan; the general procedures for data analysis and reporting; and the products of a verification test. An overview of the sequence is shown in Figure 1.

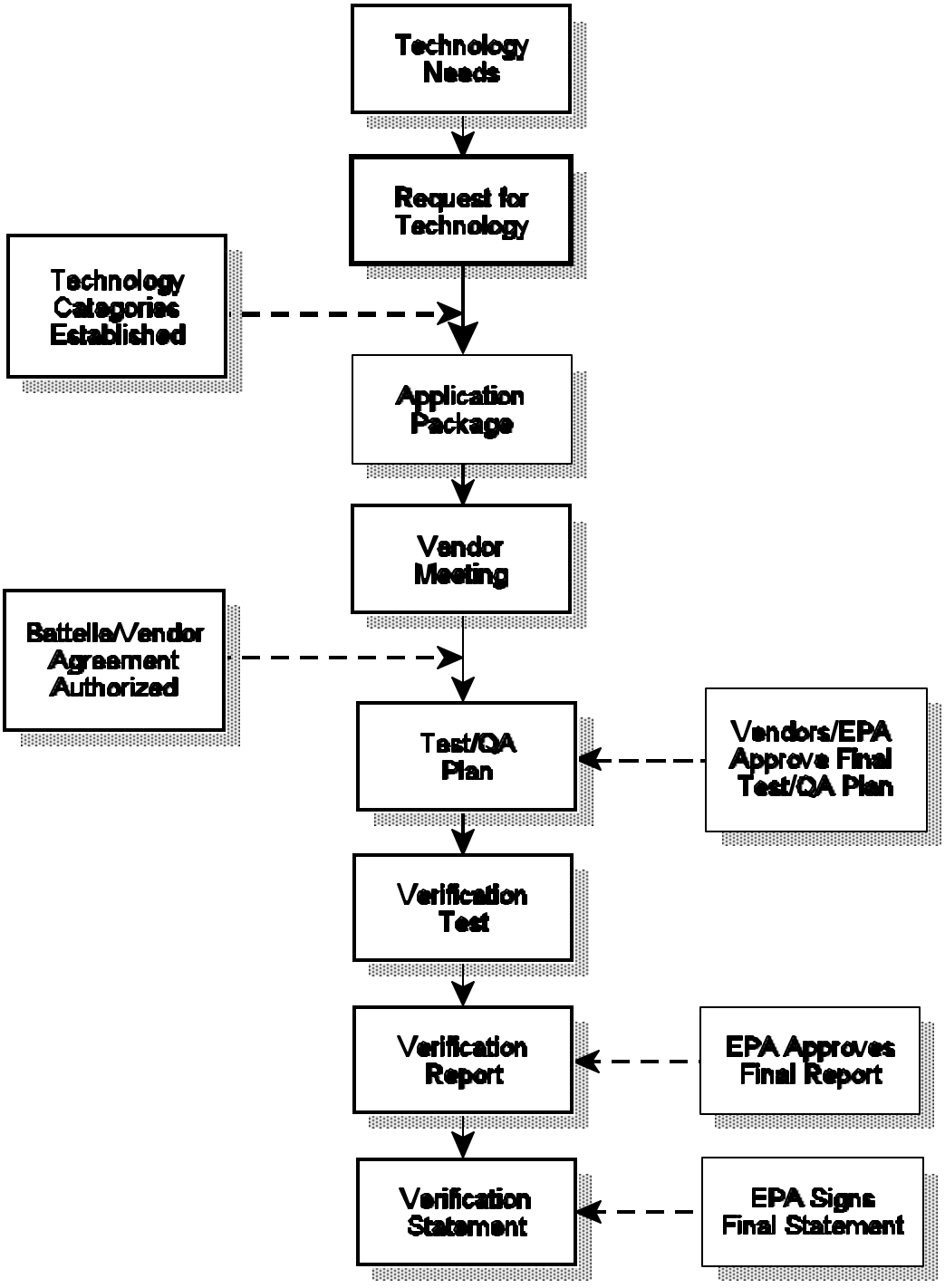


Figure 1. Steps involved in the AMS verification process.

2. PATHWAY TO A VERIFICATION TEST

A series of steps must take place before a verification test can be conducted on a monitoring technology. Those steps are described below, and examples of documents related to these steps are included as Appendices to this protocol.

2.1 Priority Technology Needs

The process of technology verification begins with the identification of high priority monitoring needs, through one or more meetings of AMS stakeholders, EPA, and Battelle staff. The stakeholders recommend key areas in which improved monitoring technologies are both needed and commercially available. Both of these factors are important, since the ETV program is intended to improve environmental conditions through application of new technology, but is restricted to verification testing of commercial-ready available technologies. The need for monitoring technologies, and the commercial state of such technologies, change with time. As a result, identification of priority needs is an iterative process, in which previous recommendations are reviewed and updated, or replaced with more appropriate or timely technologies. This activity takes place through twice-yearly meetings with the AMS stakeholder committees.

2.2 Request for Technology

Following identification of the priority technology needs, a Request for Technology (RFT) document is prepared. An example RFT is shown in Appendix A of this Protocol. The RFT summarizes the technology needs and serves as an initial invitation to vendors to submit their technologies for verification. The RFT requests summary information about the technology proposed, and about the vendor organization. The purpose of the RFT is to obtain enough information to categorize the technologies proposed, and to assess the vendor's degree of interest and readiness for testing.

To be effective in reaching vendors of verifiable technologies, the RFT must be distributed widely. A number of resources are used to identify prospective vendors, including lists of exhibitors at technical conferences; lists of members in trade and scientific associations; vendors

known by Battelle, EPA, and stakeholders; vendors advertising in trade and technical publications; distribution of the AMS newsletter to a large list of organizations; and publication of AMS announcements in journals, magazines, and on the World Wide Web. Locating prospective vendors often requires direct contact by phone or electronic mail to prompt a response or answer a vendor's questions.

Once an RFT has been filled out and submitted by a vendor, it undergoes a screening and categorization process. The purpose of this process is to focus AMS activities on the most appropriate technologies, and to make verification testing as efficient as possible. Screening of RFT responses is based on at least the following criteria:

1. Is the technology applicable to air, water, or soil monitoring?
2. Does the technology address one of the priority technology needs stated in the RFT?
3. Does the technology appear sufficiently commercial-ready for verification testing?
4. Is testing likely to be feasible within the AMS pilot?
5. Does the RFT submitter have the legal right to commit the technology for verification testing?

In addition, other factors may play a role in assessing an RFT response, such as the extent of information provided with the RFT response, or the responsiveness of the vendor when subsequently contacted.

Those RFT responses that are acceptable based on the screening process then are subjected to a categorization step. The RFT responses are grouped first by their area of application (air, water, or soil), then by the priority technology need they address, and if necessary, by the type of measurement technology they employ. This latter grouping is done so that test/QA plans may be developed efficiently, i.e., it may be preferable to conduct separate tests on technologies based on different principles, even though they address the same technology need. Additional categorization may be based on factors such as the sample type, sample matrix, or target analytes relevant to each technology. One potential benefit of the categorization process is identification of groups of similar technologies that could undergo simultaneous verification in a

single verification test. Although an individual technology may be the subject of a test, testing of technology groups is more efficient and cost-effective. Planning for verification testing then consists of developing a test/QA plan for each technology or technology group identified.

2.3 Application Package

After technologies and/or groups of similar technologies have been identified based on the RFT responses, an Application Package (AP) is sent to the vendors of those technologies. The AP is a form that requests detailed information on the vendor's technology, and on any previous evaluation or verification of its performance. The AP also requests information on current users of the technology, states the responsibilities of a vendor participating in the AMS pilot, and invites the vendor to recommend test procedures, sample types, test sites, sampling locations, and technology characteristics to be verified. The exact nature of the information requested may vary from one AP to another, depending on the technology and sample matrix of interest. An example of an AP is enclosed as Appendix B.

The two main purposes of the AP are to reconfirm the interest of vendors in having their technology verified under the AMS pilot, and to gather the information needed to plan a verification test. Verification testing in the AMS pilot will take advantage of accepted testing procedures whenever possible, and the AP is the first tool by which vendors' knowledge of such procedures is surveyed. Test procedures established by testing organizations such as the American Society for Testing and Materials (ASTM) or the American National Standards Institute (ANSI), or used in previous tests by industry groups, government agencies, or by the vendors themselves, may all be useful as the basis for an AMS test/QA plan. Similarly, the vendors may know of appropriate sampling locations or test sites, through participation in previous evaluations. Review of the AP responses, direct communications with the vendors during preparation of their responses, and discussions with stakeholders having expertise in the technology area are all used to obtain information for developing a test/QA plan.

The information gathered from the vendor's AP is used to identify the following:

- The vendor representative(s) who commit the technology for testing and who will serve as Battelle's contact during testing;
- Existing test protocols or test plans that have been used with similar technologies;
- Characteristics of a suitable test site or sampling location, and ideally a list of such potential sites;
- Practical requirements and limitations of operating the technologies during a verification test;
- Candidate schedule and location for a verification test;
- Performance characteristics on which the technology should be evaluated.

2.4 Vendor Meeting

After the information submitted by the vendors in the Application Package has been thoroughly reviewed, a meeting is held among AMS staff and vendor representatives to plan the verification testing. Discussions at each vendor meeting address only one verification test, whether that test involves a single technology or a group of technologies. The vendor meeting is generally held at Battelle's facilities in Columbus, Ohio, and typically lasts one day. The meeting is directed by Battelle verification testing staff, with typically one representative present from each participating vendor. EPA representatives, and stakeholders with particular interest or expertise in the technology area, may also participate in the vendor meeting. Discussions at the meeting are directed toward gathering information on the verification test or sampling site, the likely test schedule, and the performance characteristics to be verified. However, final revision and confirmation on these issues is conducted after the meeting. Confidentiality of vendor information is maintained throughout the meeting and subsequent discussions as appropriate. At a minimum, the agenda of the vendor meeting includes the following:

1. Introduction of AMS staff;
2. Brief overview of ETV and the AMS pilot;
3. Summary of the technology category and the monitoring need it addresses;
4. Definition of the technology: i.e., a complete measurement system ready for use;

5. Discussion of Application Package responses;
6. Discussion of existing test protocols or previous testing;
7. Discussion of previous or ideal test sites, sampling locations, or sample types;
8. Suggestion of candidate location(s), and performance characteristics targeted in the verification test;
9. Requirements and limitations of the technologies for operation during the proposed field testing.
10. Discussion of the reference method or independent standard to be used in the verification test.
11. Establishment of preliminary schedule for the verification test.

Following the meeting, Battelle staff summarize the discussions, circulate meeting notes to the meeting participants for their comments, and address action items. The primary action item coming out of a vendor meeting is to prepare a draft test/QA plan for the technology category. That step of the pathway to a verification test, is described below in Section 2.5 of this protocol. Other action items may be to obtain additional information from the vendors, to communicate questions or issues with a candidate test location or facility, or to refine the testing approach. The conclusion of the vendor meeting also triggers the sending of a verification agreement, described in Section 2.6, to all vendors involved.

2.5 Verification Agreement

At the conclusion of a vendor meeting, each vendor receives a Verification Agreement (VA) from Battelle. The VA is the contract between the vendor and Battelle, by which Battelle agrees to conduct the verification test in an unbiased manner with due attention to confidentiality of information, and the vendor agrees to participate and to pay a fee for participation in the test. Each vendor signs and returns the VA, along with the payment of the verification fee, thereby formally committing to participate in the verification test.

2.6 Test/QA Plan

Following the vendor meeting, Battelle's verification testing staff prepare a draft test/QA plan. (A description of the components of the test/QA plan is given in Section 5 of this protocol.) The draft plan is then distributed to the vendors, interested stakeholders, EPA staff, and Battelle staff with expertise in the technology area. Return of review comments within two weeks is requested. If necessary, conference calls or meetings are scheduled with vendors and others to address key issues, until all review comments are fully understood. Communication with vendors, stakeholders, EPA, and other parties continues, with the aim of resolving any conflicts and reaching a consensus on testing procedures. However, Battelle is ultimately responsible for the content of the test/QA plan. Once a reasonable effort has been made to achieve a consensus, Battelle reserves the right to make the final decision about any remaining issues.

The draft test/QA plan is then revised by Battelle in response to the comments of vendors, EPA, and stakeholders; approved by and distributed to those parties and on the ETV web site. The final version is the basis for verification of the vendors' technologies.

3. GENERAL DESCRIPTION OF A VERIFICATION TEST

A verification test consists of operation of commercial-ready monitoring technologies in a realistic application situation, according to a detailed test/QA plan, and comparison to a reference measurement method or with an accepted standard to establish the performance of the technologies. This section of the Generic Verification Protocol provides a summary description of a verification test.

3.1 Technologies Tested

As described above, a verification test may be conducted for a single technology, or for a group of technologies that address the same priority technology need. Technologies within a group selected for a verification test will likely also share the following characteristics:

- Same or compatible measurement principles;

- Same or similar target compounds to be measured;
- Nature of the monitoring location, sampling site, or sample matrix;
- Physical scale of the measurement (e.g., local or long range)
- Temporal scale of the measurement (e.g., continuous real-time *vs* time integrated);
- Mode of sampling (e.g., active *vs* passive, continuous monitoring *vs* sampling and subsequent analysis).

Similarity of technologies being tested is an advantage in defining the test/QA plan and efficiently carrying out the verification test. Field operations, quality assurance activities, and data comparisons are most efficient when the technologies tested are similar. However, applicability to the priority technology need is the primary characteristic required of any technology, and that issue overrides the attractiveness of testing closely similar technologies. As a result, diversity of the technologies to be tested can be accommodated, provided all are pertinent to the specific monitoring need.

In any verification test, a complete understanding of the technology to be tested is important. For example, in the case of a complex chemical monitoring system the verification test should address the complete measurement system, including (e.g.) sample acquisition and conditioning features, instrument controls, and data outputs. Definition of what constitutes the technology takes place at the vendor meeting and in subsequent communications with vendors.

The particular units tested must be standard and representative of the vendor's normal production of the technology. Special units or those that have been unusually selected, tuned, or refined are not acceptable. It is likely that duplicate units of a single technology will be needed for a verification test.

3.2 Field Test Site

The aim of testing is to obtain performance data that is informative and useful to the end users and permitters of the technology. To accomplish this, testing of monitoring technologies that are intended for use in the field is conducted with realistic sample matrices and under field conditions. Field sites may vary greatly, depending whether air, water, or soil monitoring

technologies are being evaluated, whether source-related or ambient environmental measurements are made, and whether field monitoring or only sample collection is needed. For some technologies, more than one field site may be needed due to geographic differences in sample characteristics, or factors such as meteorological conditions. A field site that is currently subject to compliance monitoring may be especially valuable because data obtained at such a location are clearly informative for the end user of the technologies tested. In any case, to be verified under the AMS pilot a field monitoring technology must be tested at least in part under field conditions; laboratory testing alone is insufficient for verification of technologies intended for field use.

Selection of sites is based on several sources of information, including input from vendors, EPA, and stakeholders, and the experience of Battelle staff. In some cases, the results of verification activities in the laboratory may guide the selection of field sites, for example when interferences or matrix effects make some sites inappropriate. The availability of an on-site reference method or calibration system may also be a factor in site selection. The nature of the monitoring determines whether more than one site is required for a verification test. For example, monitoring needs that might require more than one site are measurement of fine particulate matter (for which regional differences in particle composition and meteorology are important), and measurement of drinking water contaminants (for which regional patterns in chemical contaminants may be important). The characteristics of any test site(s) should include:

- The site(s) must be representative of those at which the technologies undergoing testing would actually be used;
- The site(s) must provide one or more realistic sample matrices, representative of those to which the technologies would be applied;
- In the case of multiple technologies undergoing testing, the site(s) must not offer a competitive advantage to any technology over others;
- The site(s) must be available in a period sufficient for verification testing;
- The site(s) must be such that a verification test can be carried out in a cost-effective and timely manner;

- The site(s) must not require extensive modification prior to conducting a verification test;
- The site must offer sufficient access, space, power, support facilities, etc., for operation of the tested technologies;
- If on-site monitoring is to take place, the site(s) must have, or be capable of accepting, a reference method or accepted calibration standard for comparison with the commercial technologies.

These characteristics show that a test site must be realistic but also adaptable to verification testing. In the ideal case, a reference method would already be present at a suitable test site. However, as described in the next section, alternatives exist for cases in which no such reference method exists.

3.3 Basis of Comparison

Verification testing requires a basis for comparison, with which to quantify the performance of a tested technology. This basis is ordinarily a different method of measuring the same target analytes, i.e., data from the tested technology are compared to those from a reference method. However, the degree of development of the standard method, or even the existence of a standard method, may vary from one verification to another. Consequently, three situations may be encountered in identifying a basis of comparison for a verification test:

- An EPA method exists for the intended monitoring;
- A generally accepted reference method established by another organization exists;
- No generally accepted method exists, but calibration standards or reference materials can serve as a basis for performance testing.

The approach to verification testing in each of these situations is described below:

When an EPA method exists that is applicable to a verification test, it will generally be the first choice for use as the basis of comparison. Examples of EPA methods include Standards

of Performance for Stationary Sources Appendix A - Test Methods (40 CFR Part 60); Ambient Air Monitoring Reference and Equivalent Methods (40 CFR Part 53); Methods for the Determination of Metals in Environmental Samples (EPA/600/R-94/111); Methods for the Determination of Organic Compounds in Drinking Water (EPA/600/4-88-039); and Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (EPA/600/4-89-017). An EPA method used in a verification test must be performed according to its published procedures, including those for calibration and other quality control activities. However, consideration will also be given to the current acceptance of the EPA method; an EPA method that has fallen into disuse or been generally displaced by a non-EPA method may not be the most credible basis for comparison.

It is likely that for some verification tests no EPA method will exist. In those cases an acceptable basis of comparison may exist in the form of well-documented and commonly accepted reference methods established by other reputable organizations. For example, *Standard Methods for the Examination of Water and Wastewater* jointly developed by the American Public Health Association (APHA), the American Water Work Association (AWWA), and the Water Environment Federation, might be considered for reference methods. Such methods will be adopted when appropriate as the basis for verification testing. In some instances, even when an EPA method exists the characteristics of the EPA method (e.g., time response) may limit the data comparisons that can be made. In such cases, measurements with the EPA method may be augmented by other reference methods. However, the performance of those additional methods must also be quantified by comparisons relative to the EPA method, so that all verification test results are in turn referenced to the EPA method.

In selecting an EPA method or other reference method as the basis of comparison, the following requirements should be met:

- The method must have sufficient sensitivity, linear range, precision, specificity, etc., to provide a valid basis for comparison to the commercial technologies;
- The method is already in place or can readily be implemented, if necessary;

- The results from the EPA or reference method must be available promptly enough to facilitate comparisons with the commercial technologies;
- The costs of using the EPA or reference method must be acceptable within the context of the verification test.

Finally, no clear choice of EPA or reference method may exist for a particular technology to be verified. In those cases, quantitative performance verification may be achieved by relying on standards or reference materials available from organizations such as the National Institute of Standards and Technology (NIST). In this scenario, agreement relative to the standards is the basis of comparison, rather than agreement with a reference method. Preparation of a standard or reference sample may also be needed, when no suitable standard is available. However, reliance on a non-certified standard, prepared by Battelle or another organization, is acceptable only when some external comparison to a certified standard can be made. For example, preparation of standard water samples containing diverse target analytes could be acceptable, provided that some of the target analytes can be verified by comparison to a certified standard.

Selection of the basis of comparison is based on review of published methods, on input from vendors, stakeholders, EPA staff, and on discussions with technology users. The standard basis for comparison is stated in the test/QA plan, and thus is subject to review as part of that document.

3.4 Data Comparisons

The data obtained from commercial technologies during a verification test are compared to those from a reference method, or to standards or reference materials, to quantify the performance of the technologies. For technologies that give a quantitative measurement, at a minimum, the following characteristics will be determined for each technology tested:

- Accuracy
- Precision
- Detection limit

- Linear range
- Data completeness
- Cost.

Examples of other characteristics that could be determined include reliability, interferences, matrix effects, response stability, ease of use, maintainability, safety measures, response, and use of consumables.

To achieve consistency and cost effectiveness, a verification test may be conducted simultaneously on multiple technologies, and data will be collected simultaneously. However, all data comparisons are conducted relative to the standard method or reference materials(s), for one technology at a time. That is, each technology is verified independently from all other technologies undergoing testing. No intercomparison or ranking of technologies is done at any time. The specific data comparisons to be made are planned before the verification test is conducted, and the sampling to obtain the needed data is specified in the test/QA plan. The planning of data comparisons constitutes the study design portion of the test/QA plan; because of the importance of the study design, the approach to study design is presented in Section 6 of this Protocol.

Some technologies may produce qualitative rather than quantitative data, i.e., a yes/no indication or a categorization of an environmental parameter, rather than a numerical value. For such technologies verification consists of determining performance measures such as false positive and false negative frequency, response threshold, and equivalence of duplicate results. The test/QA plan for such testing will state the procedure used to compare the qualitative results with quantitative data from the standard method or reference material. The test/QA plan will also state the statistical procedures used to quantify the predictive power or uncertainty associated with each method.

3.5 Reporting

The products of a verification test are:

- Verification Report
- Verification Statement.

Preparation, review, revision, approval, and distribution of verification reports and statements in the AMS pilot is conducted according to the guidelines set out in the Quality Management Plan for the pilot.[2]

Reporting results of a verification test begins with preparation by Battelle of a separate draft verification report for each commercial technology. When multiple technologies have been tested simultaneously, each verification report contains the same description of the site, the test procedures, the test schedule, etc. However, each draft verification report contains data and verification results for only a single technology, and no reference is made to other technologies tested. The draft verification reports are reviewed by the vendors, selected stakeholders, and EPA quality management and technical staff. Battelle then revises the verification report and submits it for final approval by the EPA pilot manager. The final verification report will be distributed by Battelle to EPA and the vendor.

Upon completion of the revised final report, Battelle prepares a draft verification statement. The verification statement is a document of from one to three pages that summarizes the verification test, briefly presents the quantitative results on the performance of the technology, and states other findings such as the cost or maintenance needs of the technology. As with the verification report, this document addresses only a single technology. The verification statement is reviewed by EPA staff from both the AMS pilot and the ETV program, and after any revisions is signed by the EPA laboratory director. The signed verification statement is distributed by Battelle to EPA and the vendor. EPA will post the verification statement on the ETV program website (http://www.epa.gov/etv).

A verification report must be prepared for all AMS testing of any technology. Verification reports become EPA documents and as such are available to the public. The verification statement is not required, and no verification statement will be prepared if the vendor requests in writing that none be issued. The verification statement is an EPA-approved summary of the verification test, and the vendor is entitled to appropriate use of the verification statement in

advertising and promotional activities. In such use, the vendor must abide by the limitations of the ETV process, i.e., exaggeration of ETV results to imply approval, certification, or recommendation by EPA is unacceptable. Furthermore, the verification report and statement apply only to the specific technology tested (i.e., model, series, or type of technology), and expansion of verification results to other products is unwarranted.

4. ORGANIZATIONS INVOLVED AND THEIR RESPONSIBILITIES

Verification testing is accomplished by a cooperative effort among several groups and organizations. This section of the Generic Verification Protocol states the responsibilities of those involved.

4.1 Battelle

Battelle is responsible for the following in a verification test:

- Overall organization, budgeting, and coordination of the verification test;
- Assuring objectivity in all planning, communication, data analysis, and reporting;
- Development of the draft test/QA plan;
- Definition of the characteristics to be evaluated in the verification test;
- Coordination of review of the draft test/QA plan by EPA and vendor staff;
- Preparation of the final test/QA plan, based on the review comments received;
- Selection of a test site, and completion of arrangements to use the site;
- Communication with the test site regarding the schedule and required support for testing;
- Performance of the verification test;
- Data analysis;
- Preparation of the verification report;
- Coordination of the review of the draft verification report by EPA, stakeholders, and vendors;

- Revision of the verification report and preparation of a verification statement.

Some of the Battelle responsibilities will be met through collaboration with stakeholders, vendors, and EPA. For example, development of a test/QA plan and selection of a test site will rely upon recommendations made by stakeholders, or by the vendors in filling out the Application Package and attending the vendor meeting. Similarly, EPA quality assurance staff will assist in review of the test/QA plan and in assuring that proper data quality efforts are carried out in the tests.

4.2 EPA

EPA is responsible for:

- Providing financial support for the verification process through the AMS pilot;
- Providing guidance during preparation of the draft test/QA plan;
- Reviewing the draft test/QA plan;
- Providing QA oversight during the verification test;
- Reviewing the draft verification report;
- Reviewing the verification statement;
- Providing final approval of documents, including the test/QA plan, verification report, and verification statement.

4.3 Stakeholders

AMS pilot stakeholders have the following responsibilities:

- Attend meetings with EPA and Battelle staff, to guide the selection of key technology needs;
- Provide input on commercial-ready technologies, and assist in identifying vendors of those technologies.
- Comment on and help improve the distribution and effectiveness of the RFT;

- Provide guidance to Battelle staff in understanding and using information received from vendors via the application package;
- Review draft/QA test plans;
- Assist with AMS pilot outreach, including communication of benefits to colleagues, regulators, vendors, technology users, and others.

In addition, stakeholders may provide input in their areas of expertise by attending vendor meetings, suggesting test sites or procedures, and recommending standard methods or reference materials to be used in verification testing.

4.4 Technology Vendors

The vendors of commercial monitoring technologies who participate in a verification test have the following responsibilities:

- Provide detailed information on the operation and sampling requirements of the technology;
- Commit a staff member to be the point of contact with AMS staff;
- Participate in a vendor meeting, and provide input for planning of verification tests;
- Review and comment on the draft test/QA plan;

1.Approve the final test/QA plan;

- Commit the technology for the duration of the verification test, along with an operator, if needed;
- Provide test data from the technology in a form suitable for use in the data comparison effort;
- Review the draft verification report;
- Pay a fee for participation in the AMS pilot.

The last item will change substantially over time, in that the AMS pilot is expected to progress from being largely subsidized by EPA funding to being largely supported by vendor

contributions. This transition will take place over the first few years of the pilot. The exact financial requirement placed on vendors will depend on the speed of this transition, the cost of verification testing, and the number of vendors participating in a test.

4.5 Test Site

The responsibilities of a facility or sampling site that agrees to serve as a verification test site include the following:

- Communicate with AMS staff in planning for the verification test;
- Allow access to the site by AMS and vendor staff for the verification test;
- Provide safety and other on-site orientation as needed;
- Commit a facility staff member to be the point of contact with AMS staff;
- Provide space and access for vendors, and common utilities if needed to conduct the test (electrical power, shelter, air, water);
- Provide information on (e.g.) the operating conditions of the facility or environmental conditions at the site, during testing;
- Provide data from on-site monitoring methods such as CEMs, as appropriate to the verification test;
- Contribute to accurate description of the test site in the verification report.

5. TEST/QA PLAN

The test/QA plan is a document which states in detail the procedures to be used in the verification test. It is the exact description of how the verification test is to be done, focusing on a specific technology category and a specified standard method. The draft of the test/QA plan is prepared by Battelle based on vendor input, then reviewed by stakeholders, vendors, and EPA staff, and by staff from the test site if necessary. The components of the test/QA plan may vary somewhat depending on the technologies tested, but will generally include the following:

- Front Material (title page, disclaimer, table of contents, lists of figures and tables, executive summary, abbreviations and acronyms)
- Introduction (description of ETV and the AMS pilot, nature and purpose of the verification test)
- Organization and Responsibilities (identification of participating organizations and their roles)
- Technology Descriptions (descriptions of the participating technologies, including operating principles and requirements, and using schematics, photographs, etc., as necessary)
- Site Description (location and nature of the site or facility used, including site history, emissions information, quantitative characteristics such as flows, temperatures, nearby source impacts, etc., and using maps, schematics, etc., as necessary)
- Basis of Comparison (description of methods or standards that serve as the basis for the verification)
- Study Design (types and numbers of samples to be analyzed or data to be collected, and comparisons or statistical analyses to be made with the data; see Section 6)
- Field Procedures (practical operations to be carried out to obtain needed samples or data, including locations, schedules, collection media, data recording, etc.)
- Quality Assurance (quality control procedures and quality assurance oversight to be implemented in the verification test, including types and number of calibrations and standards, sample custody, data acceptance criteria (e.g., completeness, performance of reference method), etc.; See Section 7)
- Data Reduction and Reporting (data management and organization, confidentiality and separation of data from different technologies, report preparation and review).

6. STUDY DESIGN

The study design is a critical part of a verification test, since it establishes the data to be collected and the comparisons to be made with the data. Efficient performance of verification testing requires that these decisions be made before testing begins, so that needed data are delivered. In the AMS pilot, study design is conducted using the data quality objectives (DQO) process, by applying the guidelines for this process set out in EPA's G-4 guidance document.[3] The study design process involves AMS staff who will direct the verification testing, other Battelle staff with expertise in statistical study design, stakeholders with expertise in the technology area, and the technology vendors, who provide information on the capabilities of their technologies.

The aim of the DQO process is to establish the type, number, and manner of data to be collected, before data collection, by considering the intended use of the data. The process is organized into a series of steps,[3] which are summarized below in terms of their application in the AMS pilot. Not all steps are equally applicable to any particular study. Furthermore, the DQO process is not a linear sequence of these steps, but an iterative process in which steps may be reconsidered to improve the study design.

6.1 State the Problem

The first step in the DQO process is to state what problem or question the data are intended to address. In the AMS pilot, the problem is generally to assess the accuracy, precision, detection limit, etc., of a monitoring technology. Clearly stating the problem generally requires reviewing existing information to fully understand the problem. Such information generally consists of the technical characteristics required to address a monitoring need, and the results of previous evaluations of the commercial technologies.

6.2 Identify the Decision

In the AMS pilot this step generally consists of a quantitative statistical statement of what decision point is to be reached. For example, what range of linearity is to be verified, or what

degree of uncertainty is tolerable in assessing accuracy or precision? This step thus provides a quantitative goal for data collection, to be met by a well-designed data collection effort.

6.3 Identify the Decision Inputs

The purpose of this step is to identify the data needed to meet the decision criteria established in the previous step. The products of this step are the types of samples or measurements needed to verify the technologies, and associated factors such as the concentration ranges or approximate numbers of samples needed. Although statistical uncertainties may be considered in this step, generally this step is only an identification of needed data. Statistical considerations leading to uncertainty estimates and decision errors are generally incorporated in later steps.

6.4 Define the Study Boundaries

In the AMS pilot, this step refers to establishing the range of test conditions, sampling locations, sample types or matrices, or sampling environments appropriate for the verification test. This step may not have the same meaning in the AMS pilot as it does in some other environmental sampling programs, in which (e.g.) spatial boundaries of a contaminated area or temporal boundaries of a sampling effort may be critical to the applicability of the data. In verification testing, a test site is selected based on other factors such as the relevance of the test site to potential technology users, the representativeness of the samples obtained, and feasibility of testing. The study boundaries then refer to sampling locations within that site, sampling schedules, and the capability of the standard method to provide data for comparison. Representativeness may have different meanings for air, water, and soil technologies, and for different technologies within those broad matrix areas. Geographic and meteorological factors (e.g.) may determine representativeness in ambient air sampling, whereas (e.g.) target analyte levels, hydrological factors, or matrix composition may determine representativeness for water sampling/analysis.

6.5 Develop a Decision Rule

In this step the quantitative statistical tests to be used in verifying technology performance are selected. For example, a mathematical test may be stated that will serve as the decision rule for assessing linearity. As another example, accuracy relative to a standard method may be assessed by comparison of mean values at some standard or typical concentration, or by the slope of a regression of data at multiple points. Selection of these decision rules is made by Battelle statisticians in consultation with verification testing staff. The approach in the AMS pilot is to apply decision rules that are commonly accepted and readily understood, so that the meaning of verification results is clear.

6.6 Specify Tolerable Limits on Decision Errors

This step of the DQO process is an iterative one, in that it may require adjustment of estimates made in previous steps. In this step acceptable uncertainty limits are applied to the decision approaches chosen above, and the types, numbers, ranges, etc. of the data to be obtained are reexamined. If the sampling estimates made previously cannot provide acceptable error limits for the comparisons to be made, then more or different samples, or added QC efforts, may be needed.

6.7 Optimize the Design

This final step of the DQO process involves fitting the data collection guidance from the previous steps with the realistic limitations of the verification test. Considerations include the cost of sampling and analysis, the feasibility of obtaining all the data suggested, the time available for the verification tests, restrictions at the test site, etc. This step is generally the most time-consuming one in the DQO process, and requires revisiting the previous steps to find compromises among the various factors. The product of this step is the study design that specifies what data collection activities are to be done, how many samples of what kinds are to be collected, and what comparisons are to be made with the data.

6.8 Conversion to Field Procedures

A final step, though not a part of the DQO process, is to convert the study design into actual procedures to be carried out in the verification test. Whereas the study design states what is to be done, this step establishes in a practical sense how it is to be done in the test. The products of this step are specific monitoring or sample collection procedures and schedules, instructions for collection of other data (e.g., facility operating data), and procedures for sample handling and analysis. These procedures are developed by the AMS staff who will actually conduct the verification test.

7. QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

QA/QC activities are a key part of verification testing, and as a result are formalized in the QMP for the AMS pilot.[2] That QMP is based on the requirements of the ANSI/ASQC E-4 document,[4] and on the Quality and Management Plan for the ETV program.[5]

QA/QC activities in verification testing include calibration and standardization procedures applied to measurements, the data collection and handling procedures, and oversight activities that assure that planned procedures are followed. In addition, because the AMS pilot may evaluate multiple commercial technologies at the same time, QA/QC efforts must ensure separation and security of each vendor's data in such cases. However, those efforts must also assure that collected data are free from alteration or manipulation by vendors. The specific QA/QC procedures to be followed in a verification test are detailed in the test/QA plan, and are reviewed by Battelle and EPA Quality Management staff.

8. REFERENCES

1. Performance Based Measurement System, Notice of Intent, Federal Register, Vol. 62 (193), October 6, 1997.

2. Quality Management Plan (QMP) for the ETV Advanced Monitoring Systems Pilot, prepared by Battelle, Columbus, Ohio, September 21, 1998.

3. Guidance for the Data Quality Objectives Process, EPA QA/G-4, final document prepared by the Quality Assurance Management Staff, U.S. Environmental Protection Agency, Washington, D.C., September, 1994.

4. Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, ANSI/ASQC E4-1994, American National Standards Institute, Gaithersburg, Maryland, 1994.

5. Environmental Technology Verification Program Quality and Management Plan for the Pilot Period (1995-2000), EPA/600/R-98/064, U.S. Environmental Protection Agency, Washington, D.C., May, 1998.

APPENDIX A

REQUEST FOR TECHNOLOGY (RFT)

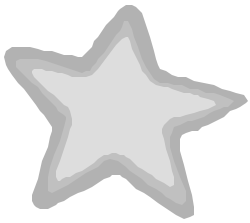
October 15, 1998

Request for Technology (RFT)

U.S. Environmental Protection Agency Environmental Technology Verification Program (ETV) Advanced Monitoring Systems Pilot

A Call for Vendors

The purpose of this Request for Technology (RFT) is to solicit the participation of vendors of air and water monitoring systems who wish to have the performance of their technology verified under the Advanced Monitoring Systems (AMS) pilot of the U.S. EPA's Environmental Technology Verification (ETV) program. The goal of the EPA's ETV program is to accelerate the acceptance of environmental technologies. EPA funds will be available until September 2000 to partially support verification testing as an incentive to encourage vendor participation and to move the pilot towards privatization.



POTENTIAL BENEFITS TO VENDORS

Vendors and developers who have their technology verified under the AMS pilot should expect considerable benefit from participating. Potential benefits include:

- Increased credibility from having independent performance data;
- Access to expertise in verifying and applying monitoring technologies;
- Possible reduction in the number of performance demonstrations needed to gain acceptance from multiple states and municipalities;
- Increased likelihood of regulatory acceptance and public recognition of technologies;
- Increased recognition in both national and international markets through promotion of verification results;
- Increased confidence for investors.

Priority Technologies Sought

Battelle and Stakeholder Committees advising Battelle on the AMS pilot have identified environmental technology needs and determined those needs for which verified monitoring systems are most critical. These priority technology needs are listed below. Vendors, developers, manufacturers, or owners of technologies that meet the following needs and who are interested in AMS pilot verification should complete and send the attached Request for Technology Submittal Form to Battelle.

Air Technology Needs

Real-time field instruments that can measure (or chemically speciate) fine particulate matter in ambient air or that correlate with the Federal Reference Method for this measurement.

Real-time automated speciating volatile organic compound monitors with sample-tolerant inlets.

Portable field NO/NO_2 analyzer for small sources (e.g., internal combustion units and small boilers).

Real-time field monitor for measurement of speciated organics and/or inorganics from point sources.

Water Technology Needs

Home test kits for measuring pathogens (fecal coliform) or metals (lead, copper) in drinking water.

Chemical-specific field probes for monitoring volatile organic compounds or synthetic organic compounds in groundwater.

Real-time field instrumentation for monitoring pathogens or synthetic organic compounds in surface water.

Rapid field measurement technology to determine the "wholesomeness" of seafood (e.g., finfish and shellfish) by measuring the presence of polycyclic aromatic hydrocarbons and other contaminants.

Request for Technology Screening

Responses to the Request for Technology will be screened against the following criteria:

1. All information requested in the RFT has been provided;
2. The monitoring system meets a priority technology need listed above;
3. The submitter has the right to commit the technology for verification testing;
4. The technology is "market-ready" meaning that it is beyond the research and development stage and is commercially available.
5. The technology's performance is verifiable and verification can be achieved with reasonable effort.

Verification Process

Vendors whose monitoring technologies meet the above criteria will be invited to complete and submit an Application Package that provides more detail, and supporting data, on their technology. Battelle will evaluate the applications, with guidance from the Stakeholder Committees, to select and rank systems for verification testing. Battelle will develop testing protocols and test plans, with Stakeholder Committee advice and vendor review. The verification testing will then be conducted according to

these protocols and test plans. Initial verification tests are expected to begin in the fall of 1998.

The products of a verification test are a Verification Test Report stating quantitatively the performance of the technology, and a Verification Statement, issued jointly by Battelle and EPA, that summarizes the verification results. A vendor can use the Verification Statement to attract prospective users of its technology by providing them with third-party quality-assured data on technology performance under realistic testing conditions. The Verification Statement will also be published on EPA's ETV website.

Vendor Involvement

Vendors who have their monitoring systems verified under the AMS pilot will be obliged to:

- Commit commercial-ready unit(s) for the duration of verification testing
- Provide operation and maintenance support during verification testing, if deemed necessary
- Provide documented procedures for operating the technology
- Review and comment on test/QA plans and verification test reports.

Depending upon the complexity of verification testing, vendors may be expected to pay user fees to supplement EPA funding during the pilot period. Once the AMS pilot has been privatized, user fees are expected to fully cover verification costs.

Background

ETV is a voluntary program intended to provide objective performance data to the environmental community. ETV does not compare, rank, endorse, approve, or disapprove technologies it validates. Rather, it applies a national, reviewed verification process, involving a cross-section of interested stakeholders, to provide technology users with objective, high-quality performance data to support technology selection decisions. ETV addresses only commercially available technologies, and does not support research or evaluate prototype technologies.

EPA selected Battelle, a Columbus, OH-based not-for-profit technology research and development organization, as its partner for the AMS pilot. The pilot will verify the performance of commercially-available technology for monitoring air, water, and soil, with air and water monitoring technologies of highest priority at this time. The AMS pilot's scope encompasses the full range of environmental monitoring technologies. Air monitoring technologies could address ambient air, stationary source emissions, or indoor air, while water monitoring technologies could address drinking water, surface water, groundwater, waste water, and sediment. Remote monitoring systems, field instruments, continuous emission monitors, and laboratory analytical instruments could all be considered for verification. Similarly, technologies could monitor for organic compounds, inorganic compounds, or biological contaminants. The focus is on technologies that are needed and available but not yet widely used.

Two Stakeholder Committees guide Battelle -- one focused on air monitoring and the other on water monitoring. Stakeholders represent regulated industries and agencies, EPA and state regulating agencies, technology users, professional and trade associations, public interest and environmental groups, and the financial community (insurance underwriters and venture capitalists). These stakeholders advise Battelle on technology needs, verification protocols, and other issues. A list of the AMS stakeholders can be found on EPA's ETV website - www.epa.gov/etv, along with more detailed information about the ETV program and the AMS pilot.

ETV Advanced Monitoring Systems Pilot

Request for Technology (RFT)

SUBMITTAL FORM

Date: _____ **Name of Submitter:** _____

Title: _____

Company Name: _____

Address: _____

Phone #: _____ **FAX #:** _____ **Email address:** _____

---

1. Name of monitoring technology: _____

2.Brief description of monitoring technology: _____

_____

_____

3. Monitoring need that technology addresses::

Air

Real-time instruments that can measure (or chemically speciate) fine particulate matter in ambient air or that correlate with the Federal Reference Method for this measurement.

Automated monitors with sample inlets specially designed for speciation of volatile organic compounds in ambient air.

Portable NO/NO_2 analyzer for small sources (e.g., internal combustion units and small boilers).

Real-time field monitors for measurement of speciated organics and/or inorganics from point sources.

Water

Home test kits for measuring pathogens (fecal coliform) or metals (lead, copper) in drinking water

Chemical-specific field probes for monitoring volatile organic compounds or synthetic organic compounds in groundwater

Real-time field instrumentation for monitoring pathogens or synthetic organic compounds in surface water

Rapid field measurement technology to determine the "wholesomeness" of seafood (e.g., finfish and shellfish) by measuring the presence of polycyclic aromatic hydrocarbons and other contaminants.

Other Need

If other, describe need and who has need: _____

_____

_____

4. Matrices that technology addresses (check all that apply):

Air

Ambient Air

Source Emissions

Indoor Air

Other

If Other, please list _____

Water

Drinking Water

Waste Water

Surface Water

Ground Water

Sediment

Other

If Other, please list _____

5. **Contaminants that technology addresses (check all that apply):**

Organic Compounds
Inorganic Compounds
Particulate Matter
Biological Contaminants
Criteria Pollutants
If technology applies to only one or a few compounds in the above categories, please list those compounds
_____

If the technology operates on a receptors/response or a indicator/effect basis, please provide detail_____

6. **Advantages of monitoring technology**:_____
_____
_____

7. **Relation of submitter to technology:**

Owner
Manufacturer
Licensee
Other
If Other, please explain _____
_____

8. **How many units sold to date?**

None
1-5
6-10
>10

If none, include evidence with Submittal Form that the technology is commercially ready.

9. Are existing performance data available? yes no

If yes, in-house, third party, or both

10. Have you participated in previous demonstrations/verification programs with this technology? yes no

If yes, please list:

Program name/sponsor: _____
_____

Date: _____Location: _____

If desired, further information can be provided by attaching no more than two additional pages. Also please enclose any available marketing brochures/technical information sheets with a schematic or picture of the technology with your Submittal Form as well.

Thank you, in advance, for your response!

PLEASE SEND COMPLETED SUBMITTAL FORMS TO:

Dr. Thomas J. Kelly
Battelle
505 King Avenue
Columbus, OH 43201
Phone: 614-424-3495
Fax: 614-424-3638
e-mail: kellyt@battelle.org

FOR FURTHER INFORMATION ABOUT THE AMS PILOT OR TO OBTAIN A COPY OF THIS FORM, PLEASE CONTACT:

Ms. Helen Latham
Battelle
505 King Avenue
Columbus, OH 43201
Phone: 614-424-4062
Fax: 614-424-5601
e-mail: lathamh@battelle.org

Or visit EPA's ETV website *(www.epa.gov/etv/) to learn more about the AMS Pilot and to obtain a copy of this form.*

APPENDIX B
APPLICATION PACKAGE FOR TECHNOLOGY VERIFICATION

ETV Advanced Monitoring Systems Pilot

Application for Technology Verification

This form requests the information and commitments needed for preparing, conducting, and reporting on the verification testing of your technology under the EPA/ETV Advanced Monitoring Systems (AMS) Pilot. Please provide the information requested as fully as possible, attach supporting documentation, and return to Dr. Thomas Kelly at the address indicated below. If information requested here was previously submitted with your RFT response, please indicate so but do not duplicate material already provided.

Thomas J. Kelly
AMS Verification Testing Leader
Battelle
505 King Avenue
Columbus, Ohio 43201-2693
Phone: 614-424-3495
FAX: 614-424-3638
email: kellyt@battelle.org

VENDOR_____

TECHNOLOGY_____

A. Requirements for Vendors

The AMS verification effort will require the following specific commitments from participating vendors:

1. Provide detailed information on your technology, including its operating requirements or limitations, descriptions of previous testing programs, and current use of the technology. This information will be used solely to plan verification testing; if you wish material to be treated as confidential please mark it, and we will return it after use.

2. Commit a person from your organization to be Battelle's point of contact, and to lead your participation in the verification program.

3. Commit the technology, and an operator if needed, to a test of approximately one month's duration at a field site. Suitable sites will be identified based on the requirements of the technologies to be tested, in collaboration with the participating technology vendors.

4. Assist in preparing for verification tests, by commenting on a generic test protocol and a detailed test plan for verification of the technology.

5. Review the verification report.

6. Pay a fee for participation in the AMS pilot. The expected cost to vendors for participation in initial verification tests is $5,000. This vendor fee will cover only a portion of the cost of the verification tests; the remainder of the cost will be covered by EPA funding of the AMS pilot.

B. General Information

1. Please provide the name, complete mailing address, phone, FAX, and email for the following representatives of your organization:

   Person authorized to commit the technology for testing:
   Name
   Title
   Address

   Phone FAX
   email

   Person who will serve as the contact point and lead your participation in the AMS pilot:

   Name
   Title
   Address

   Phone FAX
   email

Person authorized to pay the participation fee:

Name

Title

Address

Phone FAX

email

2. Please attach a detailed description of your technology, as an aid in planning verification tests. Provide instrument manuals, operating instructions, technical publications, schematics, drawings, photographs, or any other information you feel is pertinent to understanding the operation of your technology.

3. Please attach information on any previous evaluations of your technology. Provide copies of data or evaluation reports, or describe the testing including location, date, testing procedures, QA/QC activities, testing organization, and contact person.

4. If possible, identify a few current users of your technology (i.e., contact name, address, phone or email). These contacts may be used by us to obtain information about operating your technology in the field, but will not be used to assess the performance of your technology.

Name Affiliation

Address

Phone or email

Name Affiliation

Address

Phone or email

Name Affiliation

Address

Phone or email

C. Verification Testing

To make the verification process as effective as possible, we wish to take advantage of the experience of vendors in evaluating their technologies. The following items are intended to draw out any standard procedures, key requirements, or useful suggestions for consideration in planning the verification tests. Feel free to provide any other information or materials you think may be helpful in planning the verification tests.

1. Identify any standard test procedures or guidelines (e.g., ASTM, EPA, NIST) that you think should govern the testing of your technology.

2. Identify the general type of field facility (e.g., chemical plant, boiler, incinerator) that you think would be most appropriate for use as a verification testing site. You may identify specific sites if you wish, and these will be considered for use in the verification tests.

3. Attach information describing the limitations or requirements of your technology in terms of field testing. What are the requirements for field setup, electrical power, other utilities, expendables, space, presence of an operator, maintenance, waste disposal, and dismantling of the setup? Are there any key characteristics required of a test site for verification testing of your technology (e.g., location, size, or physical layout of facility, nature of emission sources, species emitted?) What training is required for those operating the technology?

4. Describe the sampling and QA/QC requirements of your technology. What are the requirements for sampling duration or frequency, sample preparation or flow rate, calibration or zeroing of the technology, etc?

5. Typically, technologies will be tested for verification of their accuracy, precision, detection limits, linearity, and data completeness, and for evaluation of operational factors such as maintenance needed and ease of use. Are there other key performance criteria specific to your technology that would be important to evaluate?

6. What parameters of your technology must be monitored during testing to assure the technology is functioning properly?

7. Are there additional verification tests you would like to see performed (for an additional fee), e.g., an extended duration in the field, or use of multiple test sites?

D. Vendor Meeting

As part of the preparations for verification testing of your technology and similar technologies, a one-day meeting will be scheduled between AMS staff and vendor representatives. This meeting will likely be held at Battelle's headquarters in Columbus, Ohio. You will be contacted to identify available dates for your company to participate in this meeting. Please provide the name(s) of the person(s) who will be representing your company at this meeting and their fax and telephone number if not previously listed in this application.

Representative(s) to Attend Meeting

Address

Phone FAX

email

E. Commitment Signature

Your commitment to participate in the AMS pilot's verification testing and requirements listed in Section A will be indicated by the signature of an authorized representative of your company:

For (Company Name)

Signature

Print Name

Title

Address, phone, FAX, email (if different from those given in B.1)

_____

_____

_____

_____

A complete formal agreement for signature by both your company and Battelle will be provided once final details of the verification testing and vendor requirements have been established.